NEBRASKA PUBLIC RADIO MUSIC DATA CENTER

An Architectural, Thermal, Acoustic, Hydrologic, and Civic Design Thesis

Proof-of-concept massing and civic frontage. The sweeping shell profile is a fixed conceptual datum for design development, not a disposable visual style.

Governing proposition

The data center computes for the network, cools through disciplined thermodynamics, breathes through the Nebraska landscape, receives public radio as information, re-performs that information through physical air and matter, gathers atmospheric water, and returns a measurable public dividend in knowledge, sound, landscape, and water stewardship.

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By Zachary David Enfield, Hastings, Nebraska, Independent Researcher, July 2026.

Document Purpose and Status

This document consolidates the complete concept into a single architectural design thesis that can be read by architects, mechanical and electrical engineers, acousticians, landscape architects, hydrologists, public-radio institutions, utilities, public officials, community members, and prospective operators. It is intentionally written as a design brief rather than as a decorative narrative. Every poetic proposition is paired with an engineering separation, a performance requirement, or a development pathway so that the concept can move from image to plan, section, specification, prototype, and eventually construction.

The proposal remains pre-feasibility. It does not claim that audible music directly condenses atmospheric vapor, that a sorbent façade can supply the full water demand of a hyperscale data center, or that a building-wide rhythmic fan cycle is automatically more efficient than steady airflow. It instead establishes a disciplined architecture in which established cooling principles, controlled unsteady flow, acoustic attenuation, physical musical instruments, ultrasonic water extraction, water treatment, and civic programming can be tested as an integrated system. Final capacities, site boundaries, utility connections, water rights, sound limits, and environmental approvals must be determined through professional studies and public review.

Design Spine

The following principles are the fixed conceptual spine. They should survive changes in consultant team, site configuration, structural system, server technology, and development phasing. A proposal that abandons these principles may still be a data center, but it is no longer this project.

- **Preserve the proof-of-concept profile.** The large left-hand acoustic shell, the tall central vaulted fins, the planted rising foreground shell, the deep right-hand entrance arch, and the clustered vertical pipe towers constitute the recognizable architectural identity. Design development may rationalize curvature, repetition, structure, drainage, fire separation, and cladding, but it must not flatten the composition into a long rectangular industrial wall. The efficient server volume may remain orthogonal inside; the outer shells exist to shape air, sound, light, landscape, and public life around that core.
- **Design four flows together.** Data, heat, sound, and water are not separate themes applied after the plan has been settled. Their routes are to be drawn together in every major section: information enters and leaves through networks; heat leaves processors through liquid and air; radio enters as a signal and is translated into physical resonance; atmospheric moisture is captured, released, treated, stored, and returned to designated uses. The architecture is successful when these flows are legible, controllable, and mutually reinforcing without being dangerously interdependent.
- **Separate mission-critical operation from public expression.** The computing core must remain safe if every public pipe, chime, water feature, and performance valve is silent. The expressive system may borrow a controlled side-stream of air or data, but it cannot determine rack-inlet temperature, emergency ventilation, fire protection, or electrical redundancy. This separation is the central discipline that allows the project to be imaginative without becoming irresponsible.
- **Make the building the instrument.** Public music is not to be reduced to concealed loudspeakers broadcasting into a plaza. FM, AM, archival recordings, personal playback, and original compositions become control information for wind pipes, aeolian strings, tuned cavities, chimes, reeds, membranes, water percussion, and selected architectural resonators. Code-required emergency communication and

accessibility systems remain conventional and intelligible; the artistic proposition is that the public performance itself is physically made by the building.

- **Treat silence as an architectural product.** The project is an inverse concert hall. A concert hall shapes desirable sound so that it reaches the audience; this building must first prevent fan tones, compressor hum, generator noise, transformer vibration, and turbulent exhaust from reaching the community. Only after unwanted sound has been controlled may the architecture release a chosen, limited, and time-governed public voice.
- **Turn atmospheric water into a measured hydrologic resource.** Sorbent materials may capture vapor from passing air, and ultrasonic actuators may release that captured water as droplets without requiring the same thermal evaporation step used by conventional sorbent regeneration. The water must be monitored, treated according to its use, stored in clearly identified reservoirs, and assigned to technical, landscape, public, or ecological purposes. No claim of rainmaking or direct river replenishment is valid until yield, water quality, permits, and watershed impacts are demonstrated.
- **Give Nebraska a civic return.** A facility consuming extraordinary land, electricity, capital, and public attention must offer more than a fenced tax parcel. The public-radio institution, education galleries, environmental dashboard, acoustic gardens, commissioned music, water research, workforce training, and transparent resource accounting form the civic dividend. The project should make difficult infrastructure understandable rather than hiding it behind a corporate screen wall.
- **Use the Tri-City region as the preferred study area, not an unexamined conclusion.** Grand Island, Kearney, Hastings, and the intervening central corridor offer a powerful conceptual location: central Nebraska, Interstate 80, rail and fiber corridors, public-power infrastructure, universities and colleges, the Platte River landscape, and direct relevance to communities already encountering data-center development. The regional preference is meaningful, but the exact site must be selected through utility, water, ecological, floodplain, transmission, acoustic, transportation, and community analysis.
- **Make performance visible.** The building should disclose electricity, peak demand, water capture, water consumption, heat recovery, outdoor conditions, cooling efficiency, acoustic levels, and the operational source being translated into music. A beautiful shell cannot be used to camouflage resource intensity. The architecture earns trust by allowing the public to see whether it is meeting the standards it announces.
- **Prototype before monumentality.** The complete vision should be advanced through rack-level cooling tests, a one-bay acoustic lung, a small radio-to-instrument pavilion, a sorbent-and-ultrasonic water module, and an integrated public demonstrator before the full campus is committed. The building may be visually monumental, but its technologies must be proven incrementally. A disciplined prototype program is part of the architecture, not a preliminary inconvenience.

1. Nebraska at the Data-Center Threshold

Nebraska is not an abstract setting for this proposal. In July 2026, Governor Jim Pillen signed an executive order ending access to ImagiNE Nebraska Act incentives for new data centers and directing state agencies to evaluate the sector's consequences for electricity, water, land, public revenue, and communities. The order does not prohibit data centers; it marks a moment when the state is explicitly reconsidering the terms under which they should be accepted. At the same time, Nebraska reporting has documented proposals of extraordinary electrical scale, including a Google-associated project discussed in the range of roughly one to three gigawatts, as well as active or emerging projects in eastern and central Nebraska. [1][2][3]

Central Nebraska is already part of the conversation. A new data-mining facility in Grand Island was reported in 2026, and Nebraska Public Power District continues to market a Kearney-area data-center site with electric, water, wastewater, natural-gas, and redundant-fiber infrastructure. NPPD also identifies a

Gibbon industrial location east of Kearney as being near the geographic center of the United States and connected to national markets by interstate, rail, and air service. The Tri-City region is therefore not merely the author's personal preference; it is a corridor with real infrastructure, real communities, and real exposure to the decisions this document addresses. [4][5][6]

The proposal begins from a civic premise: Nebraska should not be asked to accept infrastructure of planetary importance in the architectural form of an oversized farm or storage shed. A Morton-style shell may be economical for many legitimate uses, but a multibillion-dollar computing plant with exceptional electrical, thermal, acoustic, and hydrologic effects deserves an architectural response proportional to its consequence. The project does not reject industrial efficiency. It relocates efficiency to the disciplined core and uses the surrounding volume to control the externalities that a bare industrial box commonly pushes toward its neighbors.

2. Preferred Regional Siting: The Tri-City Confluence

The preferred study area is the Grand Island-Kearney-Hastings triangle and its connecting central Nebraska corridor. This is not a recommendation to place the campus directly beside the Platte River, within a floodplain, above a vulnerable well field, or on ecologically sensitive habitat. It is a recommendation to evaluate a broad regional confluence where transportation, public power, fiber, agriculture, education, broadcasting, and Platte Basin water management are already intertwined.

The region's conceptual strength is its centrality. It is centrally located within Nebraska and near major east-west continental movement. The project could become a visible statement that digital infrastructure need not be confined to coastal technology districts or anonymous exurban industrial parks. A central Nebraska campus could connect public radio, university and community-college programs, skilled trades, agricultural technology, environmental research, and data infrastructure within one public-facing institution.

Regional Site-Selection Matrix

Study area	Strategic strength	Principal caution	Civic opportunity	Recommendation
Tri-City corridor	Central location, I-80, public power, fiber, education, Platte landscape, current regional data-center activity.	Floodplain, aquifer, agricultural land, wildlife, and water-quality constraints require exceptional siting discipline.	A shared public-radio, music, water, and infrastructure institution serving Grand Island, Kearney, Hastings, and surrounding towns.	Preferred feasibility region.
Omaha/Sarpy County	Existing hyperscale ecosystem, workforce, network density, airport and metropolitan services.	Cumulative power, land, and community impacts; risk of becoming another conventional data-center campus.	Large public audience and institutional partnerships.	Strong technical alternative; less symbolically central.
Lincoln	Research university, state government, design and engineering talent, existing large data-center investment.	High demand concentration and urban-edge land-use conflict.	Statewide research, policy, and educational visibility.	Strong institutional alternative.
Lexington/North Platte corridor	Western access, land, transmission opportunities, rail and I-80 logistics.	More limited civic-program audience and site-specific utility/water constraints.	Western Nebraska water, energy, and workforce research hub.	Secondary study corridor.

The final site must be selected through a multi-criteria process that gives water and sound equal status with power and fiber. A site that appears advantageous because of a substation or industrial zoning may be unacceptable if its exhaust path faces residences, its groundwater connection is vulnerable, its flood risk is high, or its ecological setting makes hydrologic return irresponsible. Conversely, a site with more generous

setbacks, landform opportunities, and renewable or firm power options may produce a better total project even if initial utility extension is more costly.

3. Architectural Thesis: A Building Within a Building Within a Landscape

The Nebraska Public Radio Music Data Center is organized as three nested realms. At the center sits the data vault: regular, secure, fire-resistive, highly serviced, and geometrically efficient. Around it lies the environmental interstice: a deep zone of mechanical galleries, liquid-cooling distribution, acoustic plenums, thermal storage, water-harvesting modules, maintenance access, observation routes, and structural isolation. Around that middle layer rises the civic shell: the monumental architecture visible from the prairie, the public plaza, the radio halls, the pipe towers, planted slopes, water courts, and listening gardens.

This nesting solves a fundamental conflict. Server racks, cable trays, busways, battery rooms, service aisles, and loading patterns favor orthogonal planning. Monumental public architecture may favor sweeping section, deep shade, acoustic curvature, and expressive skyline. The project should not force the server halls into impractical curves, nor should it permit the inner rectangle to dictate a blank exterior wall. The interstitial layer allows the two geometries to coexist and makes the space between them useful.

The outer shells are not façades in the shallow sense. They are occupied thickness. Their cavities hold acoustic splitters, broad turning vanes, sorbent cartridges, maintenance catwalks, tuned resonators, ventilation passages, rainwater leaders, insulation, structural ribs, and access to the public instrument. The building becomes more than a box because its envelope performs work that the conventional data center often delegates to scattered rooftop machinery, perimeter louvers, exposed cooling yards, and afterward sound barriers.

4. The Fixed Proof-of-Concept Profile

The proof-of-concept image establishes a formal grammar that is to be preserved. The left-hand shell opens as a broad, low acoustic canopy containing a suspended vertical instrument and a glazed public hall. The central mass rises through several tall, narrow, curved fins, creating a civic scale comparable to a performance institution rather than a warehouse. A planted shell climbs across the foreground toward the main entrance, while a second deep arch frames the public threshold. Behind and above these forms, clustered metallic towers identify the thermal and musical skyline.

Design development must convert this image into rational systems without substituting a different building profile. Curved walls may be resolved as families of ruled surfaces, segmented precast panels, post-tensioned concrete ribs, steel diagrids, or hybrid frames. The exact construction system may change, but the proportional relationship among the shells, voids, planted slopes, vertical instruments, and central towers should remain recognizable. The building should not become a generic glass concert hall, a rectangular data warehouse with curved entry canopies, or a collection of unrelated sculptural fins.

The central vertical elements must be assigned real duties. Some may be thermal chimneys, some may contain flues or dry coolers, some may conceal maintenance shafts, and some may be tuned sounding pipes. Their heights should be optimized through stack effect, acoustic register, structural bracing, plume dispersion, and skyline composition. A nonfunctional pipe may remain as a visual counterpoint only when it contributes to solar control, air distribution, or structural rhythm; decorative exhaust imagery without performance would weaken the thesis.

5. Orthographic Design Requirements

The concept becomes buildable only when it survives plans, sections, elevations, reflected ceiling plans, wall sections, riser diagrams, and control sequences. The following drawings should be treated as the minimum conceptual set for an architectural competition, pre-design study, or multidisciplinary feasibility package.

- **Site plan and hydrologic plan.** The site drawing must show the gradient from prairie landscape to public institution to secure technical campus. It should separate visitor arrival, buses, staff, broadcast vehicles, freight, fuel, utility yards, emergency access, and maintenance traffic. It must also show drainage areas, atmospheric-water storage, stormwater basins, constructed wetlands, potential recharge areas, protected habitat, floodplain boundaries, acoustic setbacks, and every route by which water might leave the property.
- **Ground-floor security and public-use plan.** Public radio studios, listening rooms, classrooms, performance courts, exhibitions, community rooms, restrooms, and a café or gathering area should be accessible without entering the data center. Controlled observation galleries may permit views toward cooling loops, instrument chambers, or selected server aisles through acoustic and security glazing. Technical staff, freight, and critical equipment require independent circulation, screening, and access control.
- **Transverse environmental section.** The key section should cut through the public shell, acoustic lung, sorbent bank, data vault, liquid-cooling loop, air containment, heat-recovery equipment, water collection, and thermal chimney in one drawing. It should prove that air has no direct line from fan to neighbor, that machinery is structurally isolated, that water can drain and be maintained, and that the public instrument receives only controlled noncritical airflow. The section should also show roof planting, vapor control, fire separation, access, daylight, and weather protection.
- **Longitudinal civic-acoustic section.** This drawing should reveal the visitor sequence as a series of acoustic rooms rather than one continuous atrium. The approach should move from open prairie sound into a compressed threshold, then into the tall Radio Pipe Hall, outward to the Prairie Chime Garden, upward to a listening terrace, and inward toward the Memory Hall and environmental observatory. Each space must have a defined reverberation objective and a clear acoustic separation from studios, offices, server halls, and exterior quiet zones.
- **Principal elevation and night elevation.** The principal elevation must retain the fixed profile and demonstrate how planted planes, concrete shells, wood-lined reveals, glazing, vertical pipes, and perforated acoustic screens work as one system. The night elevation should show restrained interior glow and task lighting rather than a permanently illuminated entertainment façade. The public instrument may be lit during programmed events, while quiet-night mode should preserve dark-sky conditions and reduce visual disturbance.
- **Exploded systems axonometric.** A coordinated axonometric should separate the data vault, structural frame, acoustic shell, airflow routes, water-harvesting skin, expressive instrument, public program, and landscape-water system. The image is not merely explanatory; it is a coordination tool that forces each consultant to identify interfaces, isolation joints, access requirements, and failure states. Any element that cannot be located in the exploded system has not yet been designed.

6. Thermal Architecture: Liquid at the Core, Air at the Edges

The quietest and most credible version of this building begins by moving concentrated heat into liquid as close to the processor as practical. Direct-to-chip loops, rear-door heat exchangers, or other liquid systems can remove high-density heat without requiring the room to carry the entire load through high-velocity air. Air remains necessary for memory, storage, networking, power supplies, residual loads, personnel, and many equipment types, but its burden is reduced. ASHRAE and industry guidance increasingly recognize hybrid liquid-and-air strategies as central to high-density computing. [7][8]

The air system then becomes a carefully managed safety layer rather than a perpetual indoor hurricane. Hot-aisle or cold-aisle containment, sealed penetrations, blanking panels, pressure control, variable-speed fans, and rack-inlet monitoring prevent hot exhaust from mixing back into supply air. Department of Energy guidance emphasizes that airflow management must control the entire path, because bypass air and recirculation waste fan power and create local hot spots. [9]

Equation 1 — Sensible heat carried by airflow

$$Q = \dot{m} \cdot c_p \cdot (T_{out} - T_{in})$$

Copyable linear form: Q_dot = m_dot * c_p * (T_out - T_in)

The required heat-removal rate is governed by mass flow, the specific heat of air, and the temperature rise across the equipment. Pulsation does not create heat-carrying capacity by itself; it is useful only if it improves local transfer or distribution enough to lower average flow or temperature difference safely.

Equation 2 — Fan affinity relationship

$$P_{fan} \propto N^3$$

Copyable linear form: P_fan proportional to N^3

For a similar fan operating along a comparable system curve, fan power rises approximately with the cube of rotational speed. Large speed peaks can therefore cost disproportionately more energy than their duration suggests, which is why musical or thermal modulation must never be assumed efficient without measured system benefit.

7. Pulsed Airflow: From Constant Hum to Phase-Distributed Breathing

The original insight behind the project is that a data center need not organize every fan around a perfectly constant, synchronized operating point. Carefully controlled unsteady flow can disrupt persistent thermal boundary layers, entrain cooler air into stagnant wakes, and improve mixing around difficult heat-transfer geometries. Pulsed jets and synthetic jets are legitimate tools in electronic cooling research, but their benefit depends on frequency, amplitude, duty cycle, geometry, and Reynolds number. A pulse can improve one location and degrade another; it is a design variable, not a universal cure.

The facility should therefore maintain a steady minimum safety flow and superimpose localized modulation only where sensors and testing demonstrate value. Rear-of-rack wakes, high-density heat exchangers, network cabinets, power electronics, and recirculation pockets are plausible targets. The entire data hall should not inhale and exhale in one rhythm, because synchronized acceleration would create pressure waves, tonal stacking, mechanical fatigue, and simultaneous low-flow troughs.

The preferred strategy is phase-distributed breathing. Fan walls, air movers, or localized jet arrays are divided into spatial fields. One field rises modestly while another settles toward baseline, and the control system deliberately avoids stable whole-building synchrony. The total cooling capacity remains nearly constant while local patterns resemble gusts moving through prairie grass. The public may visualize this motion, but the thermal control frequencies do not need to be audible or musically pitched.

Equation 3 — Example modulated fan speed

$$N(t) = N_0 \cdot [1 + a \cdot \sin(2\pi ft + \varphi)]$$

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Copyable linear form: N(t) = N0 * (1 + a * sin(2*pi*f*t + phi))
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This expression describes one possible local speed modulation around a baseline N_0, with fractional amplitude a, frequency f, and phase φ. In the real design, neighboring fields should use different phases and possibly nonperiodic envelopes so that the building does not develop one dominant pressure or sound rhythm.

8. Acoustic Architecture: The Inverse Concert Hall

The Sydney Opera House is relevant not because its silhouette should be copied, but because its concert spaces demonstrate that geometry, reflectors, diffusion, absorption, material, and adjustable systems can be designed as one acoustic instrument. The Nebraska project applies the same seriousness in reverse. It must absorb, redirect, de-correlate, and contain the mechanical orchestra inside, then release only a deliberate public composition in designated places and hours. [10]

Noise control begins at the source. Oversized slow fans, lower blade-tip speed, efficient coils, quiet pumps, acoustically selected transformers, low-turbulence transitions, and liquid cooling reduce what must later be attenuated. Path control then uses deep plenums, multiple turns, splitters, absorptive linings, massive shells, barriers, berms, enclosures, and structural isolation. AMCA and ASHRAE identify source treatment, silencers, barriers, enclosures, and vibration isolation as established methods, but the project enlarges those methods into architecture rather than treating them as mechanical accessories. [11][12]

Every large intake and exhaust opening should behave as an acoustic labyrinth. Air passes through broad areas at low velocity, changes direction gradually, expands into chambers, crosses absorptive or tuned surfaces, and reaches the exterior only after the direct fan path has been broken. The curved shell is therefore a multi-story silencer. Soundproofing is not a sealed box around air-cooled machinery; it is an engineered sequence that allows enormous airflow while making sound travel a longer, lossy, and nonresonant route.

Equation 4 — Blade-pass frequency

$$f_BPF = (B \cdot N) / 60$$

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Copyable linear form: f_BPF = B * RPM / 60
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A fan with B blades rotating at N revolutions per minute produces a strong tonal family at the blade-pass frequency and its harmonics. The acoustic model must compare these frequencies with the resonances of ducts, panels, pipes, chambers, and the public instrument so that the building does not accidentally amplify its machinery.

Equation 5 — Acoustic wavelength

$$\lambda = c / f$$

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Copyable linear form: lambda = speed_of_sound / frequency
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Wavelength determines how a tone interacts with the dimensions of rooms, barriers, ducts, and resonators. Low-frequency hum has long wavelengths and is difficult to block with thin materials; it requires mass, depth, distance, tuned cavities, and careful structural isolation.

9. Radio Becomes Architecture

The building receives 88.1 FM, AM radio, archived public-radio material, personal playback, and original digital compositions as source information. It does not simply amplify those sources through exterior loudspeakers. A signal-analysis system identifies pitch contours, rhythmic events, amplitude envelopes, spectral density, chord movement, speech activity, and pauses, then assigns selected features to physical instruments distributed through the architecture.

FM may produce detailed melodic assignments because its audio bandwidth is comparatively broad and clean. AM may be treated as a memory medium: speech contours, static textures, weather reports, sports broadcasts, agricultural reporting, and historic recordings can become low pipes, whispering reeds, metallic ribbons, or slow resonant gestures. A familiar song can remain recognizable through interval, rhythm, and harmonic movement while sounding unmistakably re-performed by wind, material, and space rather than replayed by a loudspeaker.

Original compositions can be written for the building's actual physical register. A composer or generative system such as Suno may create long tones suited to pipes, separated attacks suited to valves and chimes, spectral fields suited to aeolian strings, and rhythmic structures that respect pressure recovery and public sound limits. The building would possess a repertoire in the same way that an orchestra does, but the orchestration would include air pressure, valve timing, water drops, structural resonators, light, and weather.

10. The Distributed Public Instrument

- **Radio Pipe Hall.** The principal civic volume beneath the central shell contains active sounding pipes integrated into the visible vertical rhythm. Some vertical members serve mechanical or structural functions, while selected pipes receive clean regulated air from the expressive system. Their register, dynamic range, and operation must be limited so that the hall feels monumental without becoming an exterior noise source.
- **Prairie Chime Garden.** The landscaped public approach contains tuned tubes, rods, bells, ceramic or stone resonators, and metallic ribbons. Some respond to natural Nebraska wind; others are activated gently by controlled nozzles or strikers. Damping mechanisms allow the garden to become quiet at night or during severe weather, preventing the poetic idea from becoming an uncontrolled neighborhood nuisance.
- **Aeolian Galleries.** Selected shell cavities contain tensioned strings, reeds, and ribbons exposed to controlled airflow. Visitors hear them indirectly through grilles and listening alcoves, producing a sense that the architecture itself is resonating. These galleries should favor diffuse harmonic shimmer over high sound pressure and must be physically isolated from servers and studios.
- **Low-Frequency Resonance Court.** Large concrete cavities provide slow harmonic foundation through very small acoustic power. Their openings face inward into a protected court, and adjustable apertures prevent uncontrolled booming. The court is where the architecture can feel physically deep without sending bass across the property boundary.
- **Memory Hall.** AM radio, oral histories, weather archives, agricultural reports, sports broadcasts, and Nebraska voices are preserved and interpreted here. Local listening stations may reproduce speech intelligibly for archival purposes, while the larger architecture translates selected materials into abstract breath, tone, and water. The distinction preserves both documentary clarity and the building-as-instrument concept.

11. Atmospheric Water Harvesting: The Acoustic Lung Becomes a Water Organ

The addition of atmospheric water harvesting closes the project's air-water-sound loop. Porous moisture-sorbing materials can capture water vapor from ambient air. Research published in Nature Communications and summarized by MIT in 2025 demonstrated that vibrational mechanical actuation, including ultrasonic excitation, can release captured water directly as liquid droplets with an extraction-energy efficiency reported at roughly forty-five times that of heat-based extraction from the same tested material and conditions. This result concerns the extraction step, not the entire lifecycle efficiency of a full-scale building system. [13][14]

The scientifically accurate mechanism is two-stage. First, air passes across a sorbent or desiccant whose chemistry and pore structure bind water at the target humidity range. Second, after a module reaches a chosen loading state, it is isolated and vibrated at an engineered ultrasonic frequency so that the weak interactions holding the absorbed water are overcome and droplets can drain. The water molecule is not chemically broken apart; the process releases intact water from the material.

The outer acoustic lungs are an ideal architectural location for modular sorbent banks because they already require broad, low-velocity air exposure, access, pressure control, drainage, acoustic mass, and protected cavities. During favorable conditions, selected modules remain in capture mode. When saturated, dampers isolate a module, piezoelectric actuators vibrate it, hydrophilic channels collect the released droplets, and the dried module returns to service. Multiple banks cycle out of phase so the façade continues breathing while individual sections regenerate.

The music may conduct the timing envelope but must not dictate the extraction frequency. The ultrasonic carrier should remain optimized for the actuator, sorbent, loading, and structural assembly. Radio analysis may determine when groups begin, how visible water releases are choreographed, or how the public instrument responds, while the physical extraction itself remains inaudible and performance-controlled. This distinction allows one broadcast to appear simultaneously as audible pipes, silent ultrasonic work, moving light, and descending water without confusing art with mechanism.

Equation 6 — Atmospheric-water mass estimate

$$\dot{m}_w = Q_air \cdot \rho_air \cdot (\omega_in - \omega_out) \cdot \eta_capture$$

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Copyable linear form: m_water_dot = Q_air * rho_air * (humidity_ratio_in - humidity_ratio_out) *
eta_capture
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A first-order water-yield estimate multiplies air volume flow by air density, the reduction in humidity ratio across the sorbent, and an overall capture factor. Every term depends on weather, material, pressure drop, cycle time, contamination control, and regeneration performance. The equation is a feasibility frame, not a promise of yield.

12. The Water Organ Court

Released water should become an audible and visible material before it disappears into a utility tank. Each harvesting bank may discharge through a calibrated channel into a Water Organ Court where droplets, sheets, and small streams strike stone, bronze, ceramic, glass, reeds, tensioned membranes, and resonant vessels. The water is not simulated by sound effects. It physically produces the sound after the ultrasonic system has physically released it from the sorbent.

The radio-to-instrument controller can route water without wasting it. A bass phrase may send a measured flow through a large resonant vessel. Bright melodic activity may distribute droplets across fine metallic plates. Spoken AM programming may activate slow channels in the Memory Hall. The water then returns to enclosed collection, treatment, and storage rather than being consumed by the performance.

This court also makes the resource cycle publicly legible. Visitors can see that the same air passing through the building is being asked to perform several jobs: carrying residual heat, presenting moisture to sorbents, activating selected instruments, and leaving through an acoustically controlled path. The architecture turns an invisible atmospheric process into a measurable civic event without claiming that ordinary music creates water from nothing.

13. Reservoirs, Waterways, and the Public Water Dividend

Atmospherically harvested water can be stored as a resource, but its most responsible value lies in a hierarchy of uses rather than a dramatic claim of artificial rainfall. The campus should first reduce its own potable and evaporative demand, then establish whether surplus treated water can support landscape, wetland, recharge, or stream-related objectives. Nebraska's Platte Basin is governed through closely linked groundwater and surface-water systems, integrated management plans, natural-resource districts, and recovery programs; any hydrologic return must be designed with those institutions rather than poured into a channel as a symbolic gesture. [15][16][17]

The campus may contain several reservoir types. A protected technical cistern stores water suitable for cooling makeup, washdown, or other nonpotable operations. A landscape reservoir supports native planting and recirculating public water features. A research reservoir allows universities and agencies to study water quality, storage, seasonal yield, and treatment. A separately permitted ecological reservoir or recharge basin could release water into a constructed wetland, infiltration area, or managed augmentation project when water quality and basin rules permit.

The phrase "replenish natural waterways" should therefore be translated into specific design pathways. One pathway is direct surface-water augmentation through a permitted discharge that meets temperature and quality requirements. Another is groundwater recharge through infiltration, allowing water to move slowly through the soil and potentially return to connected streams over time. A third is demand substitution: every liter of harvested water that safely replaces a liter otherwise withdrawn from a municipal, groundwater, or surface source leaves that source available for other users and ecological functions. The third pathway may prove more valuable than a photogenic release into the river.

Because atmospheric yield varies hourly and seasonally, the project should publish a water budget rather than a single annual headline. The budget must distinguish gross capture, extraction losses, treatment losses, storage evaporation, recirculated performance water, technical use, landscape use, public use, ecological return, and spill. Only net delivered water should be advertised as a public contribution.

Equation 7 — Reservoir balance

$$dV/dt = Q_harvest + Q_reuse + P \cdot A - Q_demand - E \cdot A - Q_return - Q_spill$$

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Copyable linear form: dV_dt = Q_harvest + Q_reuse + precipitation*area - Q_demand - evaporation*area -
Q_return - Q_spill
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Reservoir volume changes according to harvested inflow, reclaimed inflow, precipitation over the reservoir area, demand, evaporation, permitted return to landscape or watershed, and spill. This balance should be calculated hourly or daily using actual Nebraska weather and operation data.

14. Water Quality and Separate Grades

Water released from a laboratory sorbent cannot automatically be declared potable at building scale. Prairie dust, agricultural aerosols, microorganisms, façade materials, sorbent chemistry, piping, storage temperature, and maintenance practices all affect quality. The design should therefore maintain physically separate grades and treatment trains, with cross-connection protection and continuous monitoring appropriate to each use.

- **High-grade treated water.** This stream would be produced only after filtration, disinfection, material compatibility review, and regulatory approval. It may support public demonstration taps, kitchens, or drinking supply only when monitoring proves that use safe. The project must never allow the poetry of “water from air” to outrun public-health practice.
- **Technical water.** A separate stream may support closed-loop makeup, hybrid heat rejection, equipment washdown, humidification, or other nonpotable processes. Chemistry must be matched to metals, membranes, seals, and microbial-control requirements. Using harvested water technically may provide the clearest resource benefit because it directly displaces a campus demand.
- **Landscape and ecological water.** Water for native planting, wetlands, or recharge must meet soil, plant, wildlife, and groundwater protection criteria. Storage should avoid stagnation and vector habitat. Ecological release should occur under an approved operating plan rather than as an unmeasured overflow from the public water feature.
- **Emergency reserve.** A dedicated reserve may contribute to fire-water or resilience storage only if code officials accept its reliability and if required minimum volume is guaranteed independently of variable atmospheric yield. The project should never count uncertain daily capture as the sole source for life-safety water.

15. Public Radio as the Civic Program

Public radio is not merely the input jack for the instrument. It is the institution that gives the campus a public voice, archives Nebraska experience, and keeps the project from becoming an inward-facing corporate monument. The program may include active broadcast studios, interview rooms, a public newsroom, podcast production, performance recording, oral-history facilities, a sound archive, and spaces for community programming.

Visitors should be able to watch selected broadcasts through acoustic glass, attend live discussions, record local histories, learn how radio waves and digital networks differ, and follow how a broadcast becomes an architectural score. Educational partnerships may involve Central Community College, the University of Nebraska at Kearney, Hastings College, engineering programs, skilled trades, music departments, hydrology researchers, and public-power training. The facility can create a workforce ecosystem broader than server maintenance alone.

The environmental observatory should present live and historical data without corporate euphemism. Electricity use, peak demand, water capture, water consumption, heat recovery, cooling mode, outdoor temperature and humidity, reservoir balance, property-line sound, and current musical source should be visible. The public institution becomes a place where digital infrastructure can be questioned, measured, and understood rather than simply admired.

16. Energy, Heat Recovery, and Nebraska Accountability

A beautiful data center remains an enormous energy consumer. The architecture must not use its music, water, or landscape to distract from peak electrical demand, generation impacts, transmission expansion, backup power, and ratepayer risk. The developer should disclose projected maximum demand, annual energy, ramp behavior, interconnection upgrades, firm capacity, emergency generation, carbon intensity, renewable matching, and who pays for infrastructure that exists principally to serve the campus.

Waste heat should be evaluated as a real resource with a real customer. Possible recipients include greenhouses, aquaculture, food processing, public pools, district heating, seasonal storage, snow melting, or nearby institutions. Each proposal requires temperature-grade analysis, distance, year-round demand, backup arrangements, and economics. “Heat reuse” should not appear as a decorative sustainability label without a signed or technically credible off-taker.

The project should report total consumption alongside efficiency ratios. Power usage effectiveness can improve while total load grows dramatically; water-use effectiveness can obscure the source and timing of withdrawal. Public accountability requires absolute and normalized metrics together, including peak megawatts, megawatt-hours, gallons or cubic meters, heat recovered, water returned, and acoustic performance.

17. Material, Structure, and Nebraska Weather

The data vault should use robust fire-resistive construction appropriate to mission-critical operation. Reinforced concrete, protected steel, precast systems, and composite frames may form the secure core. The public shells may use post-tensioned concrete ribs, segmented precast panels, weathering-resistant metal, stone aggregate, high-performance glazing, and selectively protected timber in interior acoustic spaces. Structural and material decisions must survive hail, severe wind, freeze-thaw cycling, intense sun, snow drift, wind-driven rain, and long maintenance intervals.

Warm wood or wood-like diffusion surfaces may line the Radio Pipe Hall, recalling the body of an instrument and controlling reflections. Exterior fins and pipes must be detailed against rattle, vortex-induced vibration, ice, bird nesting, and debris. Every active resonator requires safe tuning access, drainage, corrosion control, and a way to be silenced. The project’s beauty should emerge from durable repeatable families, not from hundreds of unique components that cannot be repaired.

The planted roofs and prairie slopes are infrastructure. They shade and insulate the shell, manage rainfall, establish security distance, reduce reflected heat, protect views, and create public circulation. Native planting should be managed as an intentional ecological system with burn, mowing, irrigation, and invasive-species plans. The landscape cannot be left as a romantic image of tall grass around sensitive equipment.

18. Operating Modes and Fail-Safe Hierarchy

- **Quiet Night Mode.** The public instrument becomes nearly silent, natural chimes are damped where necessary, exterior lighting is reduced, and mechanical controls prioritize low tonal prominence. Water harvesting may continue inaudibly if it meets nighttime sound and maintenance criteria. The community should experience the campus as a quiet landscape, not as a twenty-four-hour attraction.
- **Public Radio Interpretation Mode.** A selected FM or AM source is translated at moderate levels within the Pipe Hall, Water Organ Court, and designated gardens. The system respects scheduled hours, wind

direction, background sound, and property-line limits. The source is announced so visitors understand whether they are hearing live radio, archival material, or an interpretation.

- **Original Composition Mode.** Commissioned artists or approved generative systems may use the full expressive matrix of pipes, strings, chimes, water, valves, and light. Compositions are validated against pressure capacity, maintenance limits, public safety, and acoustic boundaries before performance. The building is treated like a large instrument requiring orchestration, rehearsal, and tuning.
- **Natural Aeolian Mode.** Control withdraws from selected elements and Nebraska wind becomes the performer. Mechanical damping and weather logic prevent excessive movement during high winds, icing, or storms. This mode reminds visitors that the building listens to the landscape rather than only broadcasting into it.
- **Thermal Priority Mode.** All expressive airflow is curtailed or reassigned to cooling, and every artistic valve assumes a neutral safe position. Public displays explain that computing protection has priority. This is not a failure of the artwork; it is the operating hierarchy made visible.
- **Emergency Mode.** Public areas close or evacuate as required, life-safety systems use dedicated intelligible communication, and fire, power, cooling, and security controls operate independently of artistic systems. Reservoirs and water features move to safe containment states. No performance function is allowed to interfere with emergency response.

19. Prototype and Development Program

The project should advance through proof rather than through a single leap from rendering to billion-dollar campus. Each prototype answers a specific question and produces data that can modify the architecture before full-scale commitment.

- **Prototype A: Rack-level thermal pulse bench.** A contained rack or heat-exchanger test compares steady flow, phase-shifted flow, synthetic jets, and localized gusts under controlled loads. It measures temperature distribution, pressure, fan power, acoustic output, component stress, and control stability. The result determines where unsteady flow belongs and where it does not.
- **Prototype B: One-bay acoustic lung.** A full-depth section of intake or exhaust shell is built with real geometry, splitters, linings, turning vanes, cladding, and maintenance access. Large-fan noise is tested across octave bands and multiple operating points. The prototype proves that the sculptural shell can move required air without becoming a resonant horn.
- **Prototype C: Radio-to-physical-instrument pavilion.** A small public pavilion receives FM, AM, and original compositions and maps them to pipes, chimes, strings, and valves. It tests recognizability, artistic quality, public sound levels, latency, tuning, accessibility, and shutdown behavior. This pavilion could precede the campus and build regional participation.
- **Prototype D: Sorbent-ultrasonic façade module.** A weather-exposed module uses Nebraska hourly conditions to measure moisture uptake, extraction energy, release time, water quality, pressure drop, fouling, freeze performance, actuator life, and maintenance burden. The test must report liters per square meter per day and energy per liter across seasons rather than extrapolating from a laboratory sample.
- **Prototype E: Integrated Water Organ Court.** A combined demonstrator links atmospheric capture, ultrasonic release, treatment, storage, physical water sound, and reuse. It establishes whether the public effect can remain beautiful while the water remains recoverable and sanitary. The demonstrator also provides a real dataset for agencies, universities, and future design teams.
- **Phase F: Modular campus expansion.** The full data center should be divided into repeatable vault and shell modules so computing capacity can grow without constructing the entire monument at once. Public and water

systems can also expand by bay. The campus should retain a coherent completed form at every phase, avoiding the appearance of an unfinished megastructure.

20. Initial Performance Brief

Exact values belong to site-specific analysis, but the design team should adopt performance categories at the beginning so that beauty cannot be traded against unmeasured externalities. Each category should receive a baseline, target, measurement method, reporting interval, and responsible consultant.

- **Thermal reliability.** All approved equipment inlet conditions, redundancy levels, fault states, and maintenance scenarios must be satisfied independently of the public instrument and water-harvesting operation. Thermal modeling must be validated by commissioning data. No artistic sequence may reduce the safety margin below the operator's approved envelope.
- **Energy and fan efficiency.** Pulsed or phase-distributed control must demonstrate lower total energy, better temperature uniformity, or a documented reliability benefit compared with the best steady-flow baseline. Peak power, control losses, and valve or actuator energy must be included. A visually compelling waveform is not a performance result.
- **Acoustic impact.** The project must meet applicable ordinance and permit limits while also demonstrating absence of prominent tones, throbs, and low-frequency intrusion at sensitive receivers. Measurements should include A-weighted, C-weighted, octave-band, tonal, and vibration analysis during normal, peak, maintenance, and generator conditions. Public music requires a separate programmed sound envelope and curfew.
- **Water performance.** Atmospheric capture is reported by module area, weather bin, energy use, water quality, and net delivered volume. Cooling withdrawal, stormwater, reclaimed water, and watershed return are reported separately. Claims of replenishment must identify the receiving reservoir, wetland, recharge basin, or avoided withdrawal and the legal authority for that use.
- **Civic access and education.** The public program should be funded, staffed, and scheduled as an operating institution rather than as a lobby display. Attendance, school partnerships, commissioned works, archive use, training programs, and public research access should be tracked. The civic dividend is part of project performance.

21. Governing Equations and Design Variables

The following equations are included in editable linear form so they can be copied into design notes, simulation briefs, spreadsheets, NotebookLM, or consultant scopes. They are conceptual governing relationships, not substitutes for detailed computational fluid dynamics, psychrometrics, structural analysis, acoustic modeling, or hydrologic permitting.

Symbol	Meaning	Principal design use
Q	Heat-removal rate	Sizes liquid and air systems and establishes thermal load.
$\dot{m}$	Air or fluid mass-flow rate	Connects flow to heat and water transport.
c_p	Specific heat capacity	Converts mass flow and temperature rise into heat removal.
N	Fan rotational speed	Controls airflow, tonal frequency, and power demand.
f, φ	Modulation frequency and phase	Coordinates distributed pulses without whole-building synchrony.
B	Number of fan blades	Determines blade-pass tonal families.
λ, c	Acoustic wavelength and sound speed	Relates frequency to room, duct, barrier, and resonator scale.

Symbol	Meaning	Principal design use
ω	Humidity ratio	Measures water vapor per mass of dry air for harvesting calculations.
$\eta_capture$	Overall capture effectiveness	Accounts for sorbent, contact, leakage, cycling, and recovery losses.
V	Stored water volume	Connects harvesting, reuse, demand, evaporation, return, and spill.

Heat transport

$$Q = \dot{m} \cdot c_p \cdot \Delta T$$

Copyable linear form: `Q_dot = m_dot * c_p * delta_T`

Use separately for air loops and liquid loops, with properties and temperature limits appropriate to each fluid.

Fan power

$$P_fan \propto N^3$$

Copyable linear form: `P_fan proportional to RPM^3`

Use as a caution when evaluating speed modulation and pressure-drop additions.

Blade-pass tone

$$f_BPF = B \cdot N / 60$$

Copyable linear form: `f_BPF = blades * RPM / 60`

Use to avoid coincidence among fan harmonics, shell cavities, pipes, and façade panels.

Acoustic wavelength

$$\lambda = c / f$$

Copyable linear form: `wavelength = speed_of_sound / frequency`

Use to understand why low-frequency noise requires deep, massive, and spatially generous attenuation.

Open-pipe resonance

$$f_n \approx n \cdot c / (2L)$$

Copyable linear form: `f_n = n * speed_of_sound / (2 * pipe_length)`

A first-order relationship for an idealized pipe open at both ends; real instruments require end correction, temperature, pressure, and geometry adjustment.

Closed-pipe resonance

$$f_n \approx (2n - 1) \cdot c / (4L)$$

Copyable linear form: `f_n = (2*n - 1) * speed_of_sound / (4 * pipe_length)`

A first-order relationship for an idealized pipe closed at one end, producing primarily odd harmonics.

Atmospheric-water yield

$$\dot{m}_w = Q_air \cdot \rho_air \cdot \Delta\omega \cdot \eta_capture$$

```
Copyable linear form: m_water_dot = Q_air * rho_air * delta_humidity_ratio * eta_capture
```

Use with hourly psychrometric data and measured module performance.

Storage balance

$$dV/dt = \Sigma Q_in - \Sigma Q_out$$

```
Copyable linear form: dV_dt = sum(inflows) - sum(outflows)
```

Expand inflows and outflows explicitly for harvest, reuse, precipitation, demand, evaporation, ecological return, and spill.

22. Conclusion: A Civic Machine for the Infrastructure Age

The Nebraska Public Radio Music Data Center is not an attempt to disguise a conventional industrial shed with expensive curves. It is a proposal to reorganize the project from its first principles so that the architecture performs the work normally scattered across anonymous mechanical yards, sound walls, fenced drainage basins, and public-relations displays. The server core remains strict and efficient. The outer thickness becomes a climate machine, acoustic barrier, water collector, public instrument, educational institution, and Nebraska landscape.

At the center, computation proceeds without interruption. Liquid loops remove concentrated heat. A steady safety-air system protects every approved operating state. Localized unsteady jets disturb boundary layers only where tests prove their value. Massive curved plenums prevent the machinery from broadcasting a permanent hum. Radio is received as information and re-performed through real pipes, strings, reeds, chimes, cavities, water, and wind. Sorbents capture atmospheric moisture; ultrasound releases it; treatment and reservoirs make it accountable; carefully permitted uses may displace withdrawal, nourish landscape, support wetlands, recharge groundwater, or augment managed water systems.

The Tri-City region offers the strongest initial setting because it joins the author’s local attachment with a genuine continental and infrastructural logic. Grand Island, Kearney, Hastings, and the central Platte corridor sit close enough to share a civic institution while remaining distinct communities with their own utilities, colleges, landscapes, and concerns. A campus here could become a place where central Nebraska does not merely host the digital economy but defines what responsible digital infrastructure should look, sound, and behave like.

The final building should appear as though the prairie has risen into a sequence of resonant shells. From a distance, the thermal and musical towers catch the Nebraska light. From the public approach, water and grass soften the monumental scale. Inside, the visitor moves among radio, data, air, vibration, and measurable environmental processes. Beyond the site, the community hears no industrial tinnitus. It encounters silence when silence is appropriate and a deliberate public voice when the building has been invited to sing.

Final proposition

Compute. Cool. Breathe. Listen. Sing. Gather. Store. Return. The architecture is complete only when every verb is drawn as a route, tested as a system, and made accountable as a public promise.

References and Technical Basis

The references below support the current Nebraska context and the principal technical claims. They do not constitute a complete code, permitting, or engineering bibliography. Final design requires applicable building, fire, electrical, mechanical, water, environmental, broadcasting, occupational-safety, and accessibility standards in force at the selected site.

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Image Note

The cover rendering is a conceptual architectural image developed during the design dialogue. It establishes massing, profile, landscape character, and the public identity of the Nebraska Public Radio Music Data Center. It is not a construction document, and dimensions, structure, fire strategy, mechanical distribution, and material assemblies shown or implied in the image must be established through professional design development.